International Journal of Mass Spectrometry 349–350 (2013) iv–xii

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Contents

Foreword

1–2

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Klaus Blaum, Yuri A. Litvinov

Regular Articles

3–8

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K.S. Sharma

9–18

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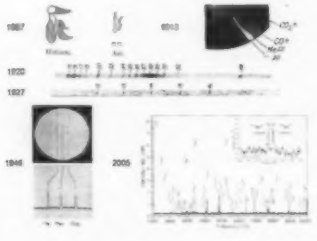
● Thomson's parabola spectrograph. ● Aston's high resolution spectrographs. ● Nier's spectrometers. ● Mattauch-Herzog and Ewald double-focusing high resolution mass spectrographs. ● ISOL, recoil, and fragment separators for rare-isotopes. ● Precision mass measurements in a storage ring.



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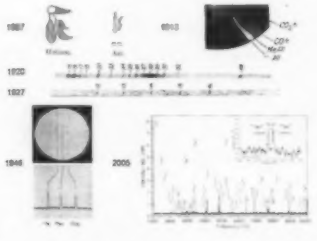

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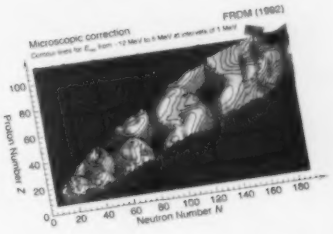
19–25

80 Years of the liquid drop—50 years of the macroscopic–microscopic model

P. Möller, A.J. Sierk

● We review the evolution of liquid-drop based nuclear mass models over 80 years. ● The original 1935 semi-empirical model of binding energies was accurate to 3 MeV. ● It was decisive for understanding radioactive decay and interpreting fission. ● The macroscopic–microscopic method [28] led to 0.6 MeV accuracy. ● The improvement is crucial for modeling nuclear stability and nucleosynthesis.

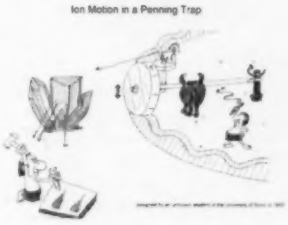


26–37

Penning trap mass spectrometry of radionuclides

H.-Jürgen Kluge

● First Penning trap mass spectrometry of radionuclides and first separation of isomers. ● First application of the Ramsey technique to Penning trap mass spectrometry. ● Highest accuracy and resolving power achieved for mass spectrometry of radionuclides. ● Invention of a new cooling technique for Penning traps. ● Invention of a cooling, accumulating, and bunching device for radioactive beams.

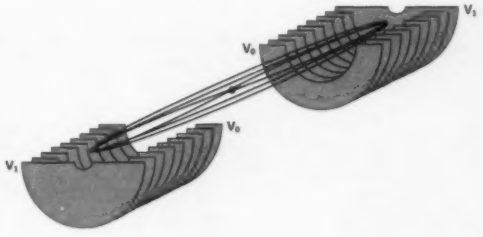


38–46

History of mass measurements in time-of-flight mass analyzers

Hermann Wollnik

● Mass measurements on short-lived high energy ions as obtained by time-of-flight mass analyzers have significantly helped to provide information on the binding energies of short-lived nuclei and thus helped to provide a basis for astrophysical calculations. ● Low-energy time-of-flight mass analyzers have become one of the major tools for the mass analysis of molecule ions and thus today are indispensable for organic chemistry. ● New developments of multi-pass low-energy time-of-flight mass analyzers are starting to obtain mass resolving powers of several 100,000.

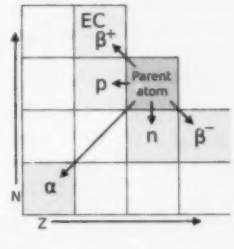


47–56

Q values of radioactive decay: Examples from nuclear physics and related fields

Ernst Roeckl, Ivan Mukha

● The motivation for the article is the 100th anniversary of mass spectrometry. ● We review the role of Q values of radioactive decay, which represent "mass links". ● Examples are given for studies of α, proton, neutron, β^+/EC and β^- decay. ● The examples deal mainly with nuclear-structure aspects. ● Relations to astrophysics and fundamental physics are briefly discussed.

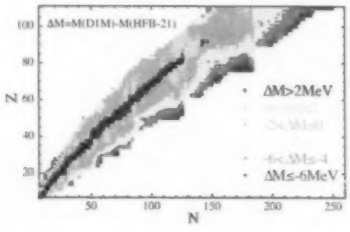


57–62

Microscopic mass models for astrophysics

J.M. Pearson, S. Goriely, N. Chamel

● We highlight the various microscopic mass models based on effective interactions that have been developed in recent years, primarily with a view to extrapolation from the mass data to the highly neutron-rich environments that are encountered in various astrophysical contexts but that are exper-imentally inaccessible. ● All these models are based on the Hartree–Fock–Bogoliubov method, and use either Skyrme-type or Gogny-type effective interactions. ● They are likewise all constrained by many-body calculations on neutron matter with realistic nucle-onic interactions.

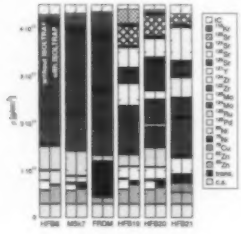


63–68

Nuclear masses and neutron stars

S. Kreim, M. Hempel, D. Lunney, J. Schaffner-Bielich

● We use the new Penning-trap mass measurement of ^{82}Zn to study its implications for the outer crust of neutron stars. ● By testing 25 different nuclear mass models, recent results excluding ^{82}Zn from the crust could be confirmed. ● We further validate that up to a density of 5×10^{10} g/cm^3, the crustal composition is determined by experimental data. ● The conclusion that magic shells ($N = 50, 82$) are a key nuclear-structure effect for the crustal composition was strengthened. ● The link of the mass of ^{54}Ca to advances in the ab initio description of neutron matter has been shown.

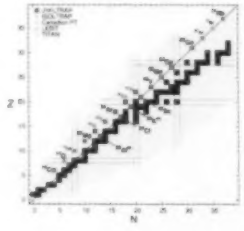


69–73

High-precision atomic mass measurements for a CKM unitarity test

Tommi Eronen, Ari Jokinen

● We overview the current status of the Q-values of the superallowed beta emitters. ● We highlight some cases which deviated significantly from previous data. ● We give some candidates for future measurements.

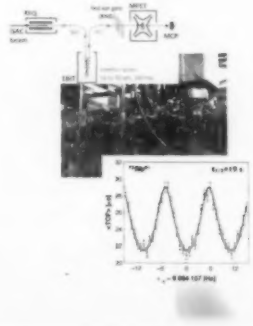


74–80

Advances in precision, resolution, and separation techniques with radioactive, highly charged ions for Penning trap mass measurements

S. Ettenauer, M.C. Simon, T.D. Macdonald, J. Dilling

● Penning trap mass measurements of radioactive highly charged ions (HCI) at TITAN. ● Short-lived nuclides are charge bred in an EBIT prior to the mass measurement. ● HCI provide a gain in measurement precision identical to the charge state of the ion. ● HCI increase the resolving power valuable for studies of low-lying nuclear isomers. ● HCI open opportunities for isobaric separation, e.g. by charge breeding to atomic shell closures.

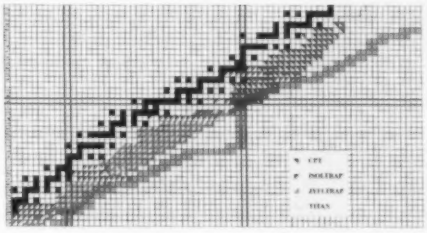


81–86

Precision masses for studies of the astrophysical *r* process

Jason Clark, Guy Savard

● We review the precise mass measurements of neutron-rich nuclides along the astrophysical *r* process. ● We review the facilities that are, or soon will be, available to provide more exotic nuclei for measurement. ● We highlight some mass measurement results which have interesting consequences for the astrophysical *r* process.

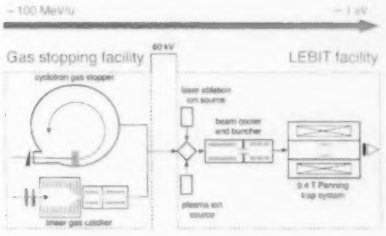


87–93

Penning trap mass spectrometry of rare isotopes produced via projectile fragmentation at the LEBIT facility

Ryan Ringle, Stefan Schwarz, Georg Bollen

● Projectile fragmentation extends the reach of Penning trap mass spectrometry of rare isotopes.
● Gas stopping techniques are used to thermalize high-energy beams for precision experiments.
● Measurements performed at LEBIT have contributed to several areas of nuclear science.

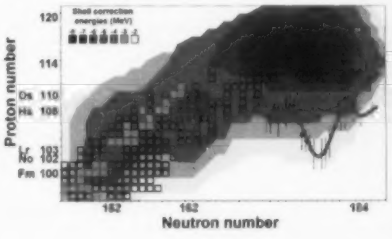


94–101

Direct mass measurements of the heaviest elements with Penning traps

M. Block

● Direct mass measurements of elements above fermium with PTMS are feasible. ● Shell effects in the region of the heaviest elements can be mapped by PTMS. ● PTMS provides powerful tools for studies of the nuclear structure in the heaviest nuclides.

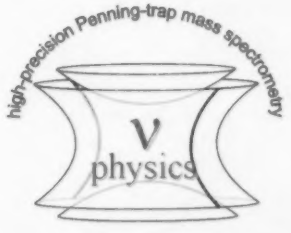


102–106

Penning-trap mass spectrometry for neutrino physics

S. Eliseev, T. Eronen, Yu N. Novikov

● The contribution of high-precision Penning-trap mass spectrometry to neutrino physics is reviewed. ● The KATRIN, MARE and ECHO experiments assisted by Penning traps aim at the neutrino-mass determination on a sub-eV level. ● Two resonantly enhanced neutrinoless double-electron-capture transitions have been found with SHIPTRAP.

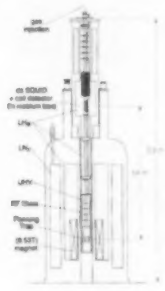


107–122

The most precise atomic mass measurements in Penning traps

Edmund G. Myers

● We review the most precise measurements of atomic masses of stable isotopes. ● We present the main motivations, methods and results. ● Motivations include determining the fine structure constant and neutrino mass. ● Methods include image charge detection of single ions in a cryogenic Penning trap.

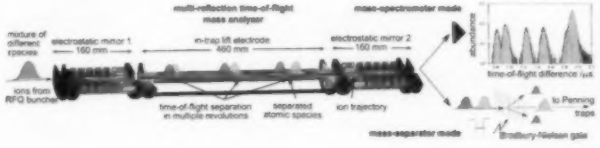


123–133

ISOLTRAP's multi-reflection time-of-flight mass separator/spectrometer

R.N. Wolf, F. Wienholtz, D. Atanasov, D. Beck, K. Blaum, Ch. Borgmann, F. Herfurth, M. Kowalska, S. Kreim, Yu. A. Litvinov, D. Lunney, V. Manea, D. Neidherr, M. Rosenbusch, L. Schweikhard, J. Stanja, K. Zuber

● Multi-reflection time-of-flight mass separator for purification of radioactive ion beams. ● Enhanced ion beam purification by stacking of multiple cleaned ion samples in an intermediate ion trap to increase the signal intensity of Penning trap mass measurements. ● Multi-reflection time-of-flight mass spectrometer for high-precision mass measurements of short-lived species. ● Multi-reflection time-of-flight mass analyzer for target and ion-source development of exotic beams.

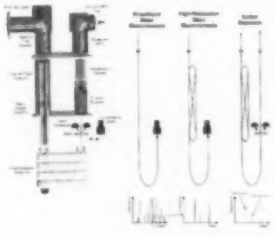


134–144

Multiple-reflection time-of-flight mass spectrometry

Wolfgang R. Plaß, Timo Dickel, Christoph Scheidenberger

● An overview of MR-TOF-MS developments for the research with short-lived nuclei is given. ● For the first time a comprehensive review of different instrumental approaches and solutions for MR-TOF-MS is made. ● A novel performance criterion for the measurement of exotic nuclei is suggested and applied to compare the performance MR-TOF-MS to that of the established technique of TOF-ICR. ● The MR-TOF-MS for the Low-Energy Branch of the Super-FRS at the Facility for Antiproton and Ion Research (FAIR) and its performance is presented. ● Applications of MR-TOF-MS at accelerator facilities as well as their scientific potential outside the field of nuclear physics are discussed.

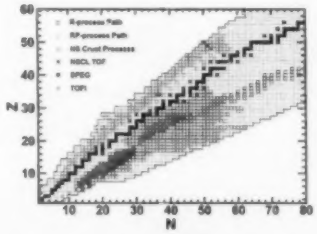


145–150

Time-of-flight mass spectrometry of very exotic systems

Z. Meisel, S. George

● We present a review of time-of-flight atomic mass spectrometry and its achievements. ● We compare time-of-flight mass spectrometry to other available mass spectrometry methods. ● An overview and outlook on time-of-flight mass spectrometry is shown.

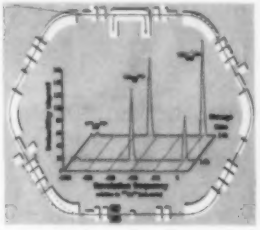


151–161

Mass and lifetime measurements at the experimental storage ring of GSI

Fritz Bosch, Yuri A. Litvinov

● Storage ring mass and lifetime spectrometry. ● Two body weak decay. ● Bound-state beta decay. ● Highly charged ions. ● Orbital electron capture.

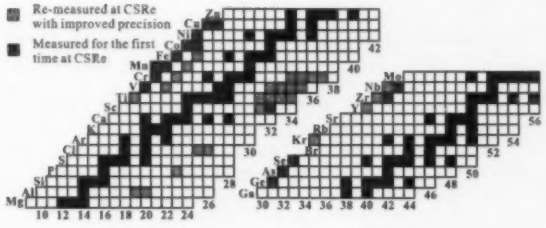


162–171

Accurate mass measurements of exotic nuclei with the CSRe in Lanzhou

Hu Shan Xu, Yu Hu Zhang, Yuri A. Litvinov

● Accurate mass measurements of exotic nuclei. ● Isochronous mass spectrometry in a heavy-ion storage ring. ● *rp*-Process of nucleosynthesis. ● Test of isobaric-multiplet-mass-equation.

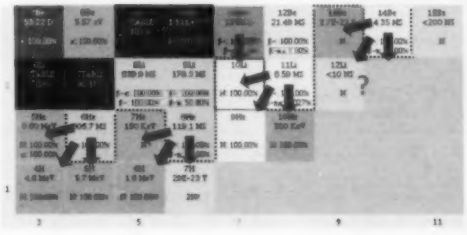


172–180

Masses of unbound nuclear systems

H. Simon

● Mass measurement for unbound nuclear systems. ● Across the drip-line(*s*): the most extreme *A*/*Z* ratios. ● Halo nuclei and other exotic systems as basis to produce very exotic systems. ● Reach outside the nuclear chart: characterize continuum states.



181–186

Nuclear masses in astrophysics

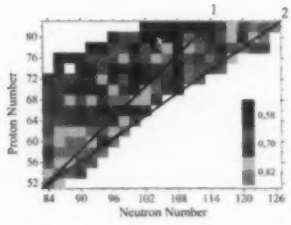
H. Schatz

187–191

Nuclear binding and nuclear structure

R.B. Cakirli, R.F. Casten

● The structure of atomic nuclei and their binding energy are linked. ● Two-neutron separation energies show effects of shell structure and collectivity. ● Double differences of binding energies isolate specific interactions. ● Empirical *p–n* interactions show bifurcated behavior near doubly magic nuclei. ● *p–n* interactions in deformed nuclei depend on spatial overlaps of nucleon orbits.

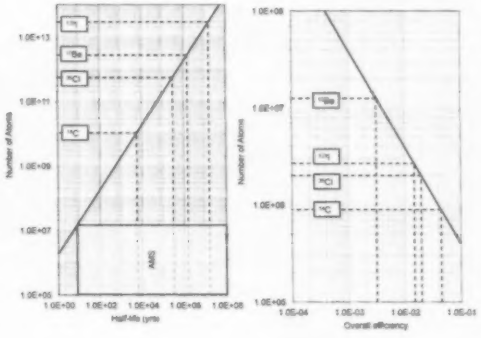


192–202

Developments in accelerator mass spectrometry

Hans-Arno Synal

● Review on technical developments in AMS over the past 35 years. ● Basic principles of AMS technology. ● State-of-the-art AMS instrumentation. ● Latest developments in AMS.

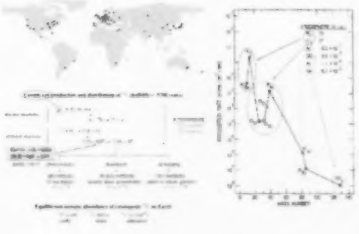


203–218

Applications of accelerator mass spectrometry

Walter Kutschera

● A comprehensive review of applications of accelerator mass spectrometry (AMS) is presented. ● The ultra-sensitive detection and application of long-lived radionuclides is discussed in broad context. ● The special role of ^{14}C as a 'gift of nature', and its boundless applications are discussed. ● Applications in the environment at large are summarized, together with an extended list of references. ● The seven domains of the environment are: atmosphere, biosphere, hydrosphere, cryosphere, lithosphere, cosmosphere, and technosphere.

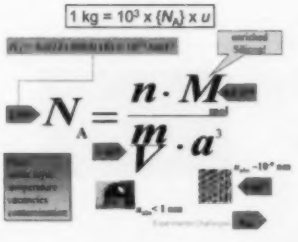


219–226

The Avogadro constant and a new definition of the kilogram

Peter Becker, Detlef Schiel

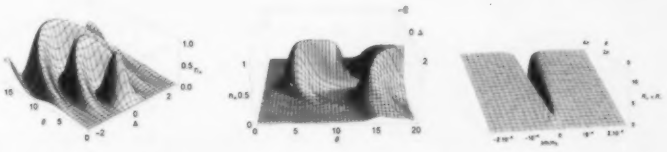
● Determination of fundamental constants. ● New kilogram definition. ● New method for molar mass determination.



227–239

Theoretical investigations of different excitation modes for Penning trap mass spectrometry

Martin Kretzschmar

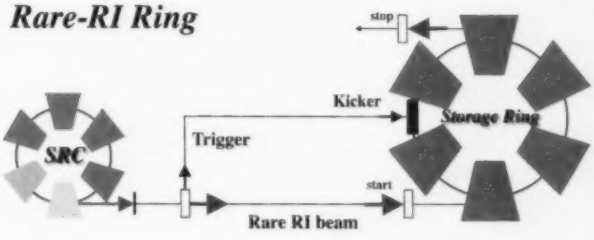


● Unified theoretical treatment of the dipolar, quadrupolar, and octupolar interactions between ions and external radio-frequency fields. ● Identification of resonance frequencies and effective interaction Hamiltonians valid in the vicinity of resonances. ● Ramsey's method of separated oscillatory fields applied to mass spectrometry is presented as an interference phenomenon. ● Equations for the interconversion of the cyclotron and magnetron modes due to octupolar rf-fields at twice the cyclotron frequency $2\nu_c$. ● Simultaneous dipolar and quadrupolar excitation applied for isobaric cleaning and mass-selective centering of the desired ion species.

240–246

The challenge of precision mass measurements of short-lived exotic nuclei: Development of a new storage ring mass spectrometry

T. Yamaguchi, Y. Yamaguchi, A. Ozawa

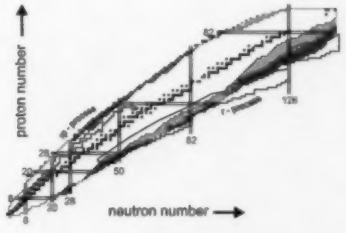


● Precision masses of exotic nuclei define the r-process pathway. ● A new storage-ring mass spectrometry is proposed. ● Individual injection method with the fragment separator is invented. ● Cyclotron-type isochronous storage ring is designed. ● RI beam science will be expanded at RIBF.

247–254

The ILIMA project at FAIR

P.M. Walker, Yu. A. Litvinov, H. Geissel

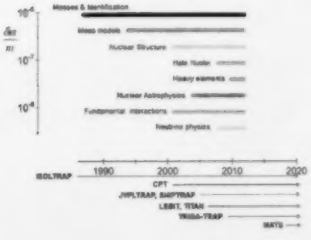


● We present the prospects for rare-isotope storage-ring measurements at FAIR. ● A summary of present storage-ring capabilities is presented. ● Access to the most exotic nuclides is provided using projectile fragmentation. ● Masses and decay modes can be determined for highly-charged single ions. ● Novel interactions at the atomic–nuclear interface are discussed.

255–263

The advanced trapping facility MATS at FAIR

Daniel Rodríguez, for the MATS collaboration



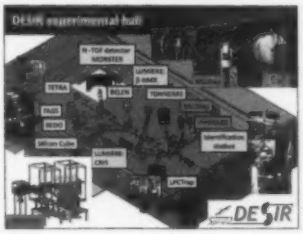
● This paper is on the future Penning-trap facility MATS, the Technical Design Report of which was already approved in 2010. ● It describes the current status on issues very important for MATS at FAIR. ● It presents news on detection techniques and the progress achieved on different elements of the facility. ● It presents a list of some possible candidates for the very first experiments at FAIR to underline the uniqueness of MATS.

264–269

Perspectives for mass spectrometry at the DESIR facility of SPIRAL2

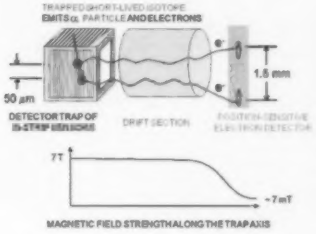
B. Blank, S. Grévy, P.G. Thirolf, C. Weber

● Short description of the future DESIR facility. ● Description of the MLL Penning trap system of mass measurements at DESIR. ● Description of the PIPERADE facility for high-resolution mass separation at DESIR. ● Future possibilities for mass spectrometry and mass separation in DESIR.



270–276

Developments in Penning trap (mass) spectrometry at MLLTRAP: Towards in-trap decay spectroscopy

C. Weber, P. Müller, P.G. Thirolf

● A "detector trap" inside a Penning trap magnet is developed for the future MATS facility.
● A direct, *in situ* observation of nuclear decays of mass-separated isotopes becomes feasible.
● A novel type of recoil-distance experiment is envisaged.